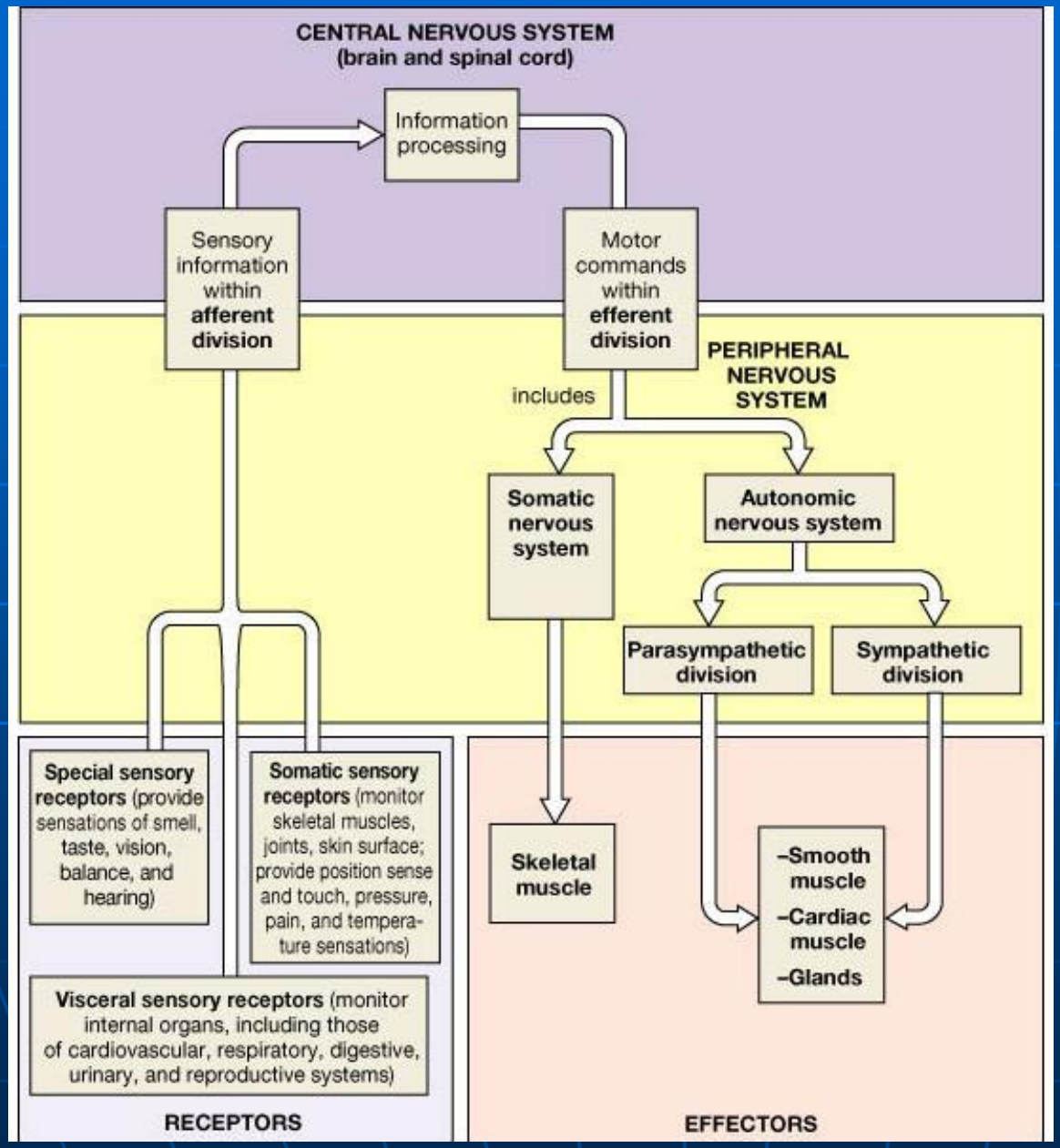
Ch 15: Autonomic Division of NS

Compare and contrast the structures of the sympathetic and the parasympathetic divisions, including functions and neurotransmitters.

Show the levels of integration in the ANS, and compare these with the SNS.

Developed by
John Gallagher, MS, DVM

LAS POSITAS COLLEGE


CENTRAL NERVOUS SYSTEM
(brain and spinal cord)
Information processing
Sensory information within afferent division
Motor commands within efferent division
PERIPHERAL NERVOUS SYSTEM
includes
Somatic nervous system
Autonomic nervous system
Parasympathetic division
Sympathetic division
Special sensory receptors (provide sensations of smell, taste, vision, balance, and hearing)
Somatic sensory receptors (monitor skeletal muscles, joints, skin surface; provide position sense and touch, pressure, pain, and temperature sensations)
Visceral sensory receptors (monitor internal organs, including those of cardiovascular, respiratory, digestive, urinary, and reproductive systems)
RECEPTORS
Skeletal muscle
–Smooth muscle
–Cardiac muscle
–Glands
EFFECTORS

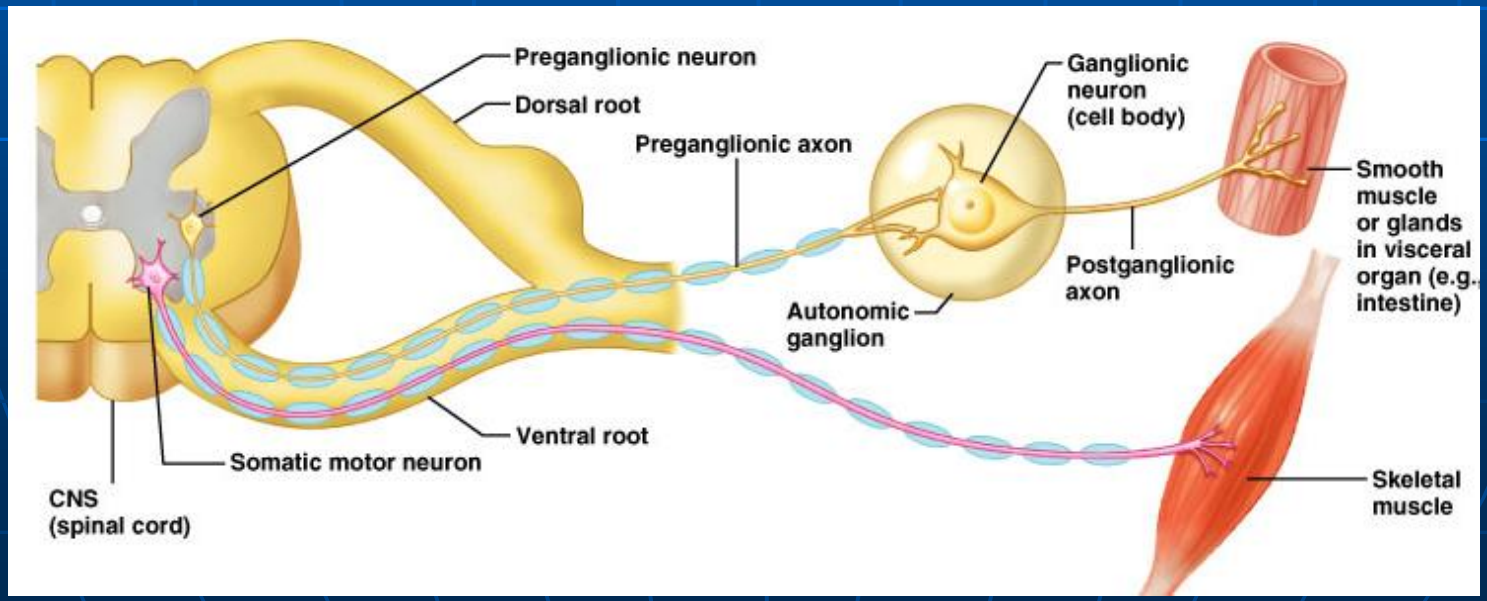
ANS is all efferent!

Overview of ANS

Pathway for Visceral Motor Output

The somatic NS uses one effector nerve but the ANS output always involves <u>two</u> neurons between the CNS (brain and spinal cord) and effector.

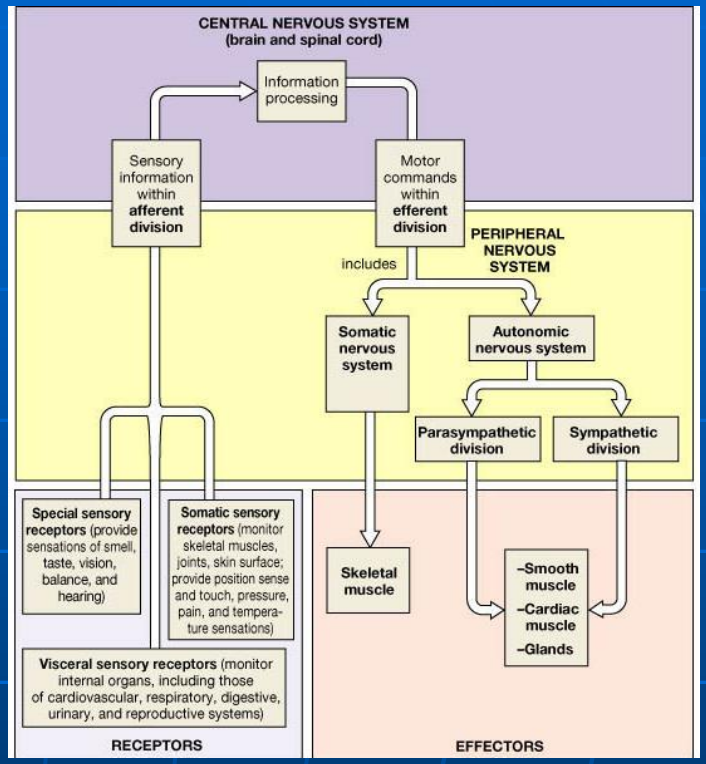
Fig 15.2



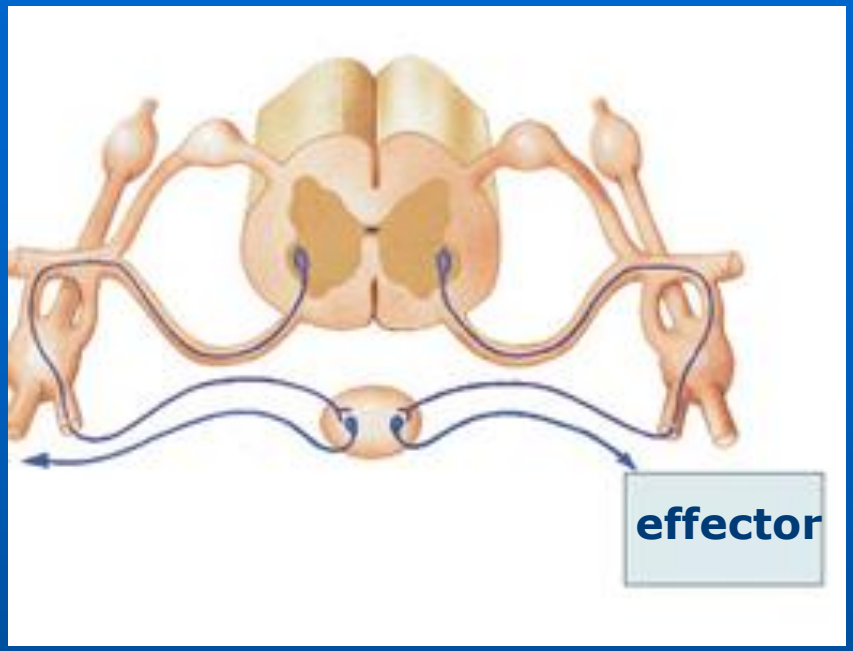
Overview of ANS

ANS has two divisions with both structural AND functional differences:

1. **Parasympathetic – Rest and Repose**
    1. **Craniosacral output**
    2. **Digestion, "housekeeping"**
    3. **Postganglionic axons release Ach (Cholinergic)**
2. **Sympathetic- Fight or Flight**
    1. **Thoracolumbar output**
    2. **Heart Rate, Respiration**
    3. **Vasoconstriction**
    4. **Postganglionic axons release NE (Adrenergic)**


CENTRAL NERVOUS SYSTEM
(brain and spinal cord)
Information processing
Sensory information within afferent division
Motor commands within efferent division
PERIPHERAL NERVOUS SYSTEM
includes
Somatic nervous system
Autonomic nervous system
Parasympathetic division
Sympathetic division
Special sensory receptors (provide sensations of smell, taste, vision, balance, and hearing)
Somatic sensory receptors (monitor skeletal muscles, joints, skin surface; provide position sense and touch, pressure, pain, and temperature sensations)
Visceral sensory receptors (monitor internal organs, including those of cardiovascular, respiratory, digestive, urinary, and reproductive systems)
Skeletal muscle
–Smooth muscle
–Cardiac muscle
–Glands
RECEPTORS
EFFECTORS

ANS: Some Nomenclature



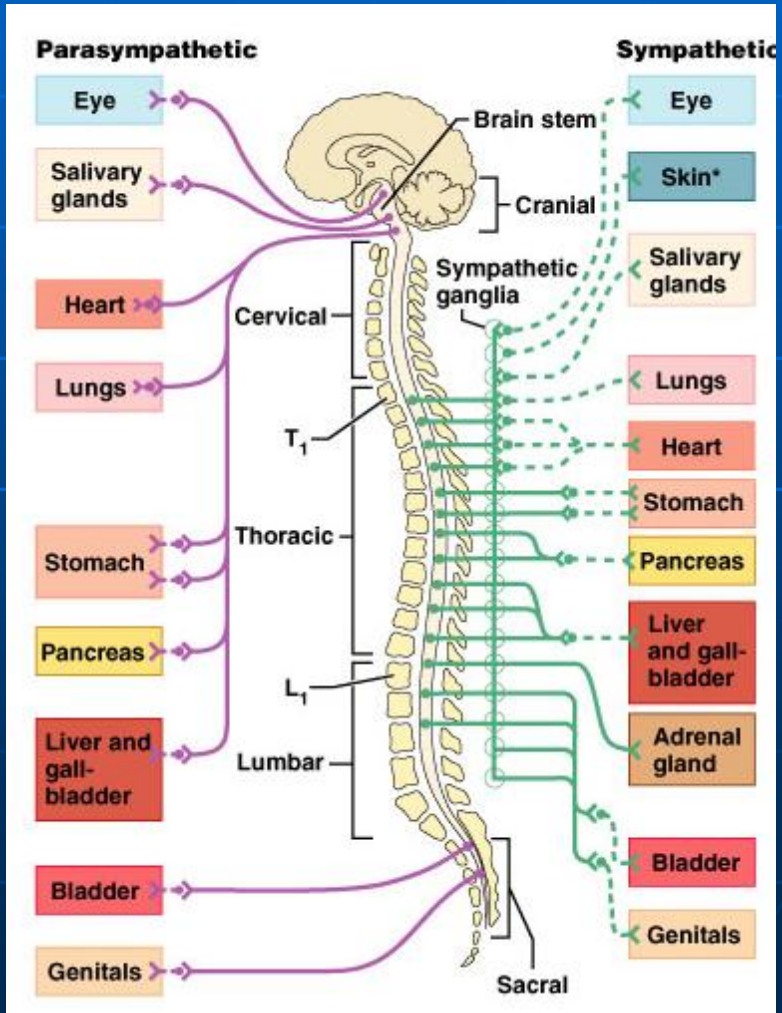
Naming of neurons:

Neuron #1: preganglionic (presynaptic)	→	Neuron #2: ganglionic (postsynaptic)	→	effector
Preganglionic fiber (=axon): Lightly myelinated		Postganglionic fiber Unmyelinated		

1. Parasympathetic Division

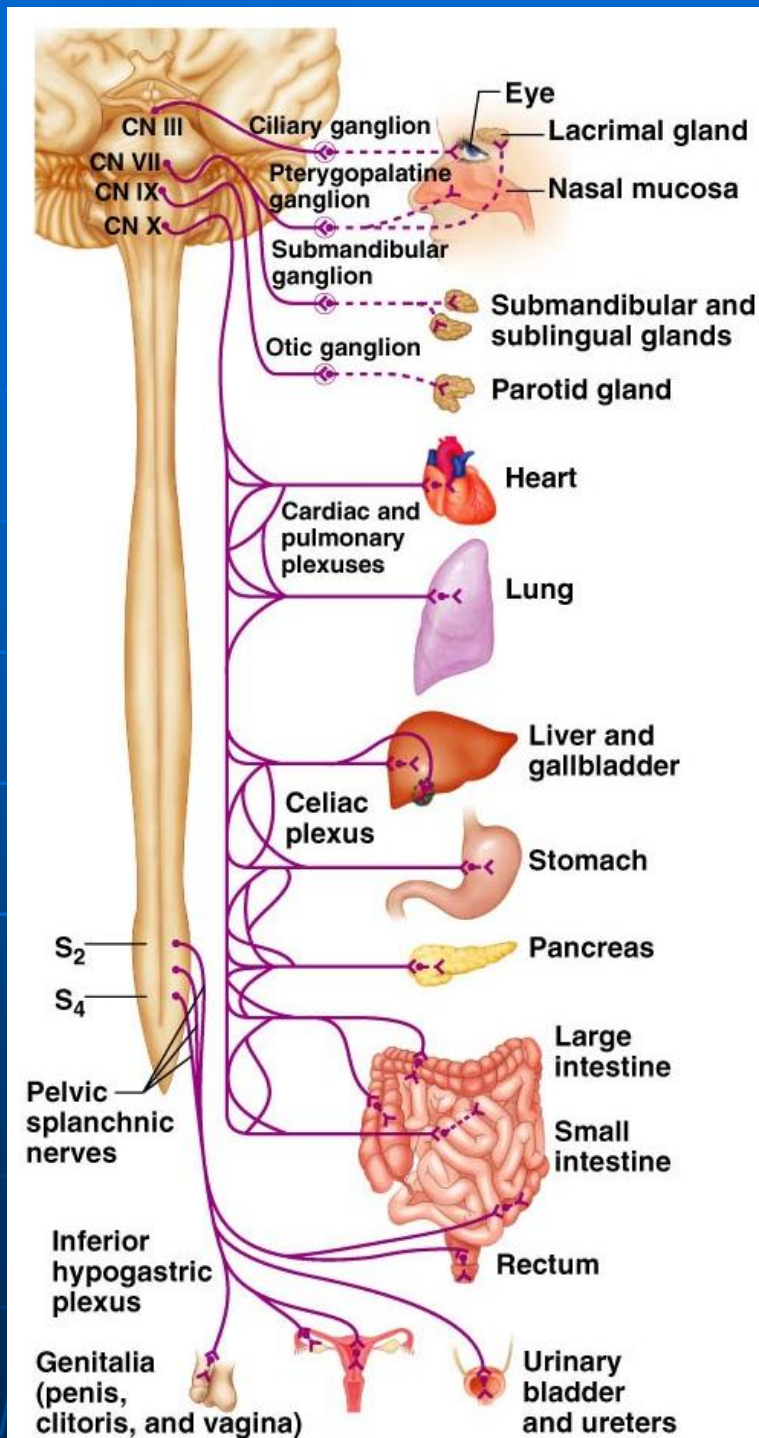
- **AKA Craniosacral** division
  - Preganglionic neurons (cell bodies) located in brain stem & sacral segments of spinal cord.
  - Cranial Nerves III, VII, IX, **X**
    - Pupils (III), Lacrimal and Salivary Glands (VII), Viscera (X)
  - Sacral segments S_{2-4}
    - Bladder, Genitals

Fig 15.3



1. Parasympathetic Division, cont'd

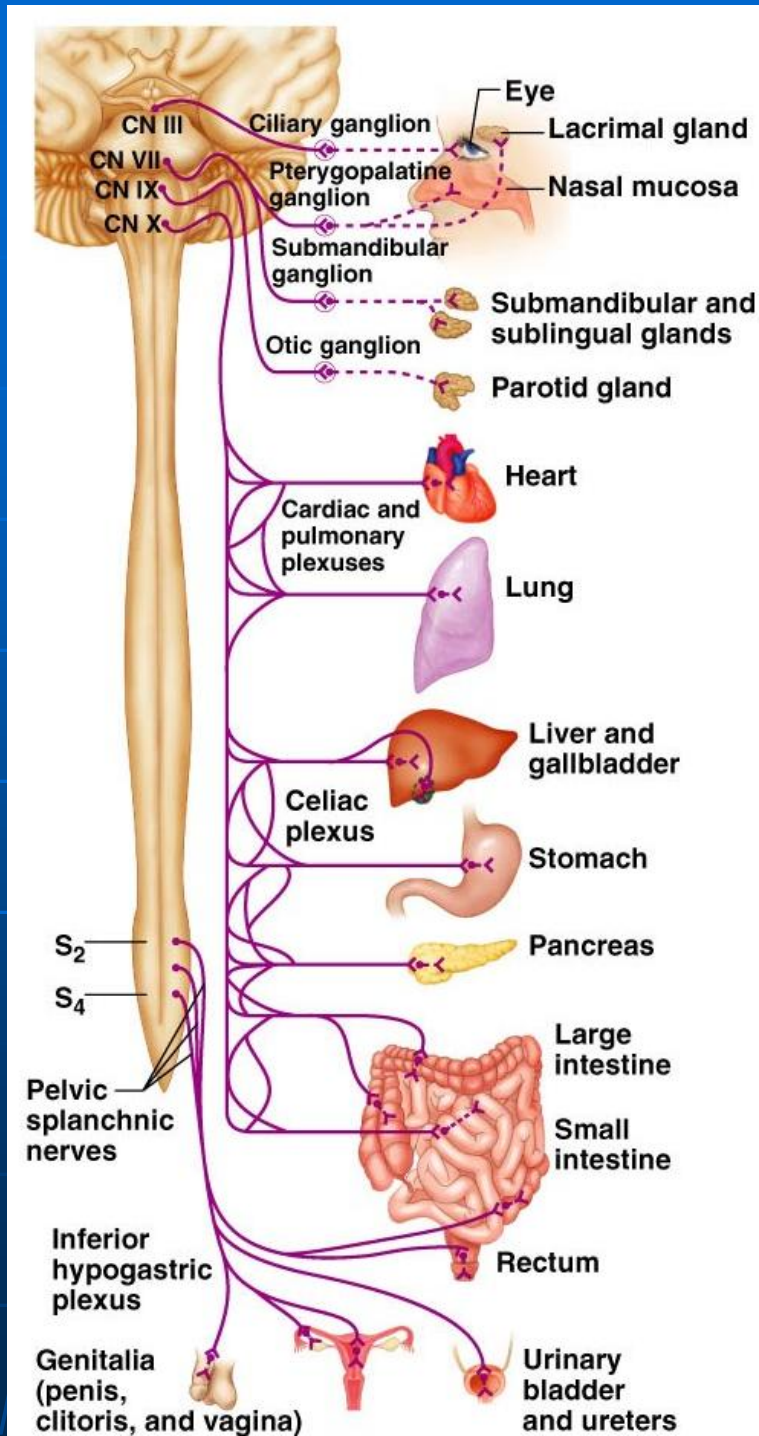
- Ganglionic neurons (cell bodies) in ganglia near target organs: Intramural ganglia
- Effects of parasympathetic division: R & R
- Synapses:
  - All use ACh



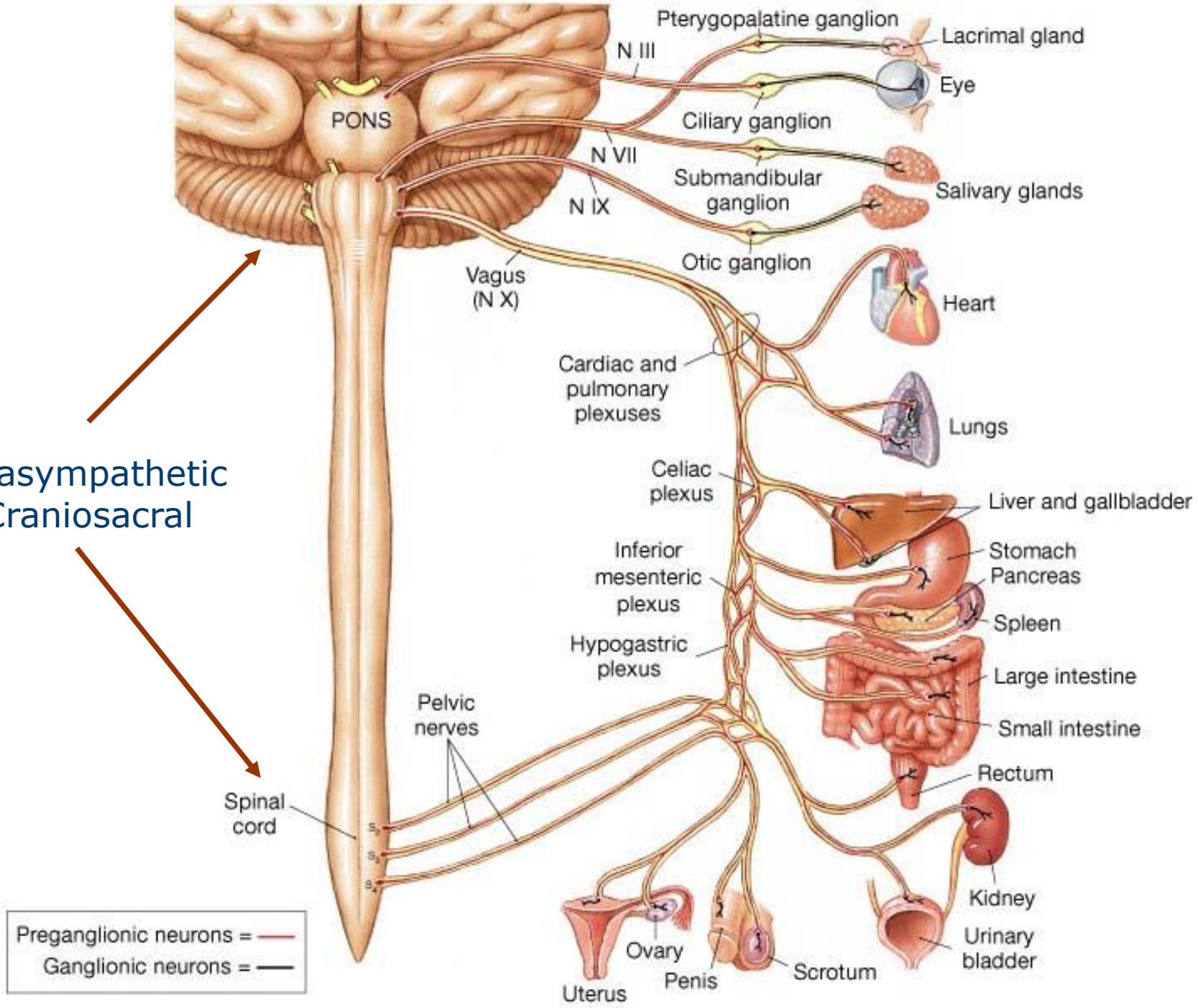
1. Parasympathetic Division, cont'd

Some functions:

- Constriction of Pupils (opposite sympathetic)
- Secretion of Digestive Glands
- Secretion of Digestive Hormones
  - Insulin, etc.
- Visceral Smooth Muscle
- Defecation and Urination
- Constriction of Respiratory System, decreases rate
- Decrease Heart Rate
- Sexual Arousal



Parasympathetic
= Craniosacral



1. Parasympathetic Division, Summary

A. Rest and repose

B. Neurons #1 are long, thinly myelinated, come from the brain stem (N III, VII, IX, X) or sacral spinal cord (S_{2-4}), run with the spinal or pelvic nerves and produce ACh.

C. Neurons #2 are short, nonmyelinated, produce ACh, and may be either excitatory or inhibitory to muscarinic receptors.

D. Mostly control of internal physiology

2. Sympathetic Division

AKA Thoracolumbar division

Preganglionic neurons (cell bodies) located between T1 & L2 of spinal cord

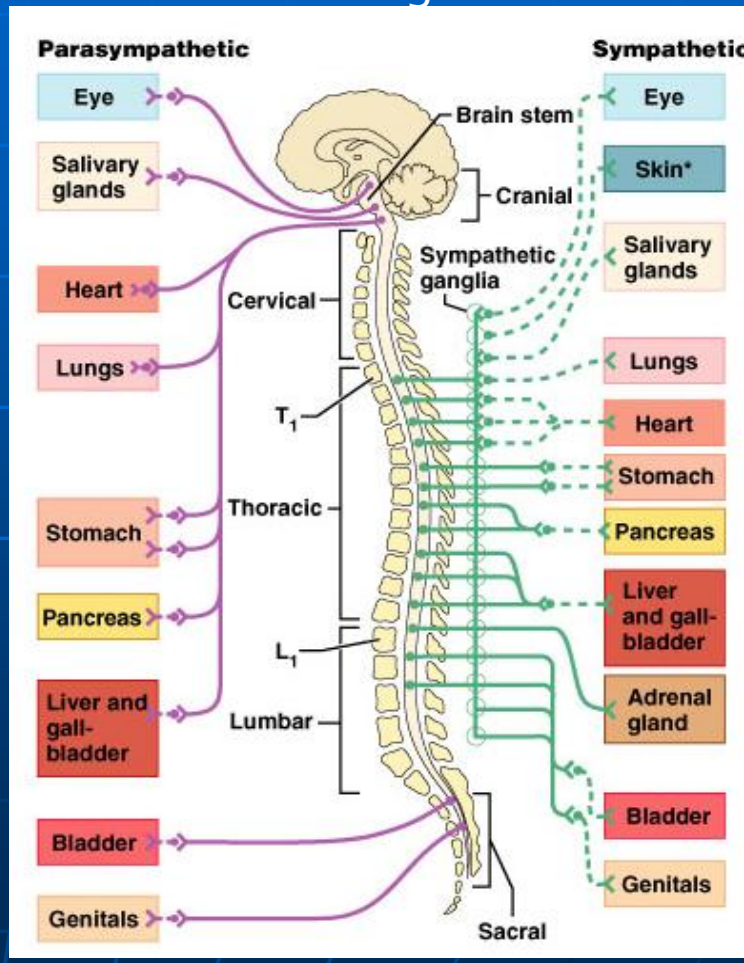
Ganglionic neurons (cell bodies) in ganglia near vertebral column, AKA “Chain Ganglia.”

- **Paravertebral ganglia** = sympathetic chain ganglia
- **Prevertebral ganglia** = collateral ganglia

Effects of Sympathetic Division? F or F

Special case: adrenal medulla is a modified ganglion

Fig 15.3



2. Sympathetic Efferent Pathways: Examples

Fig 15.11

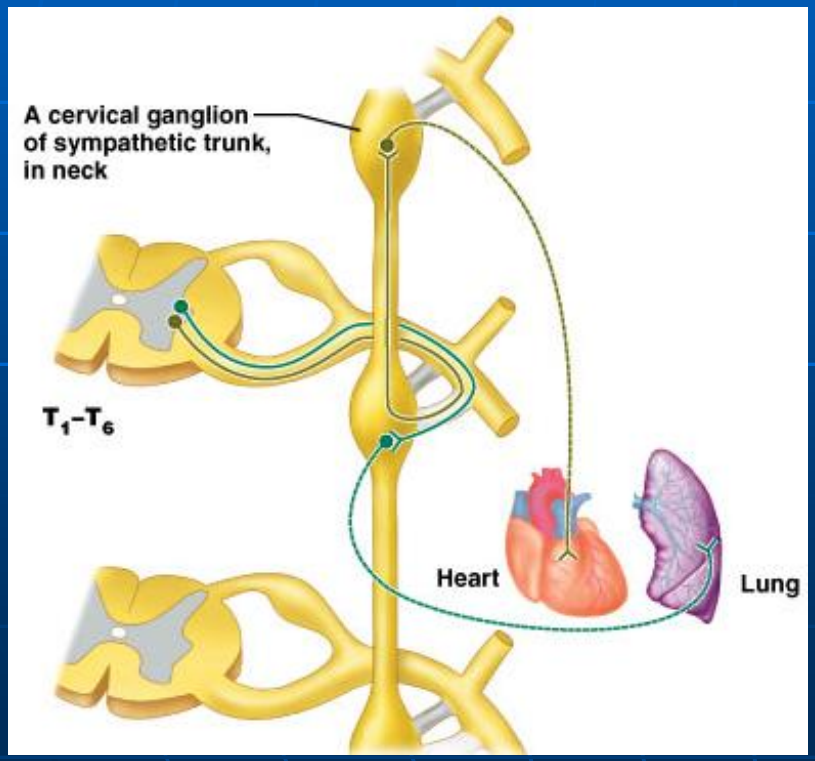
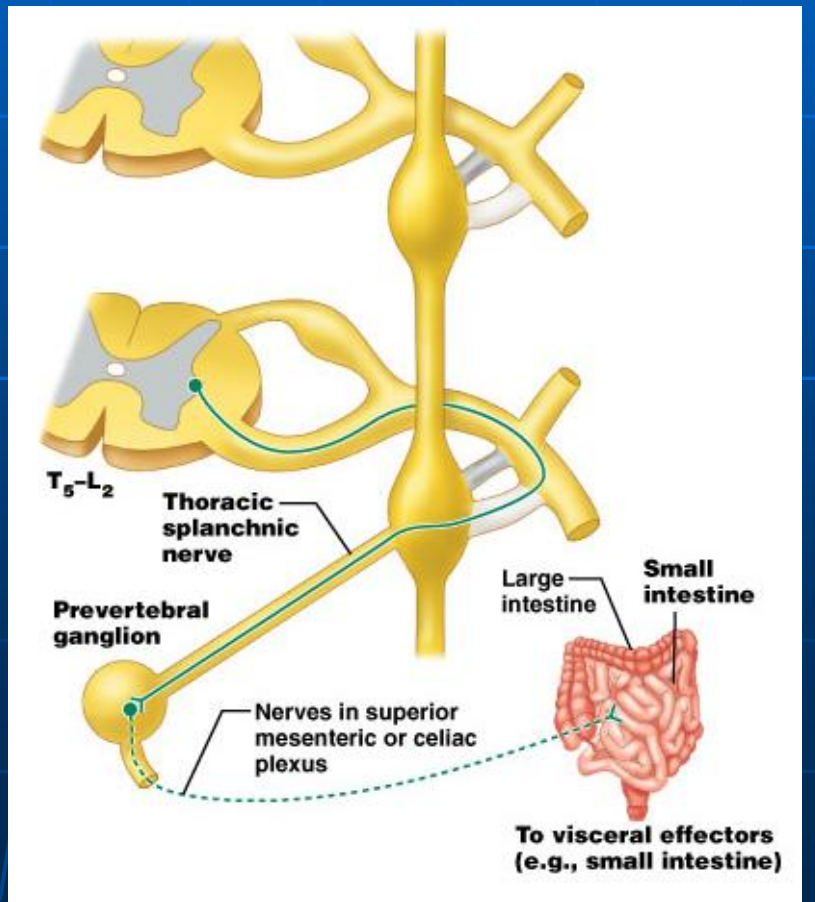


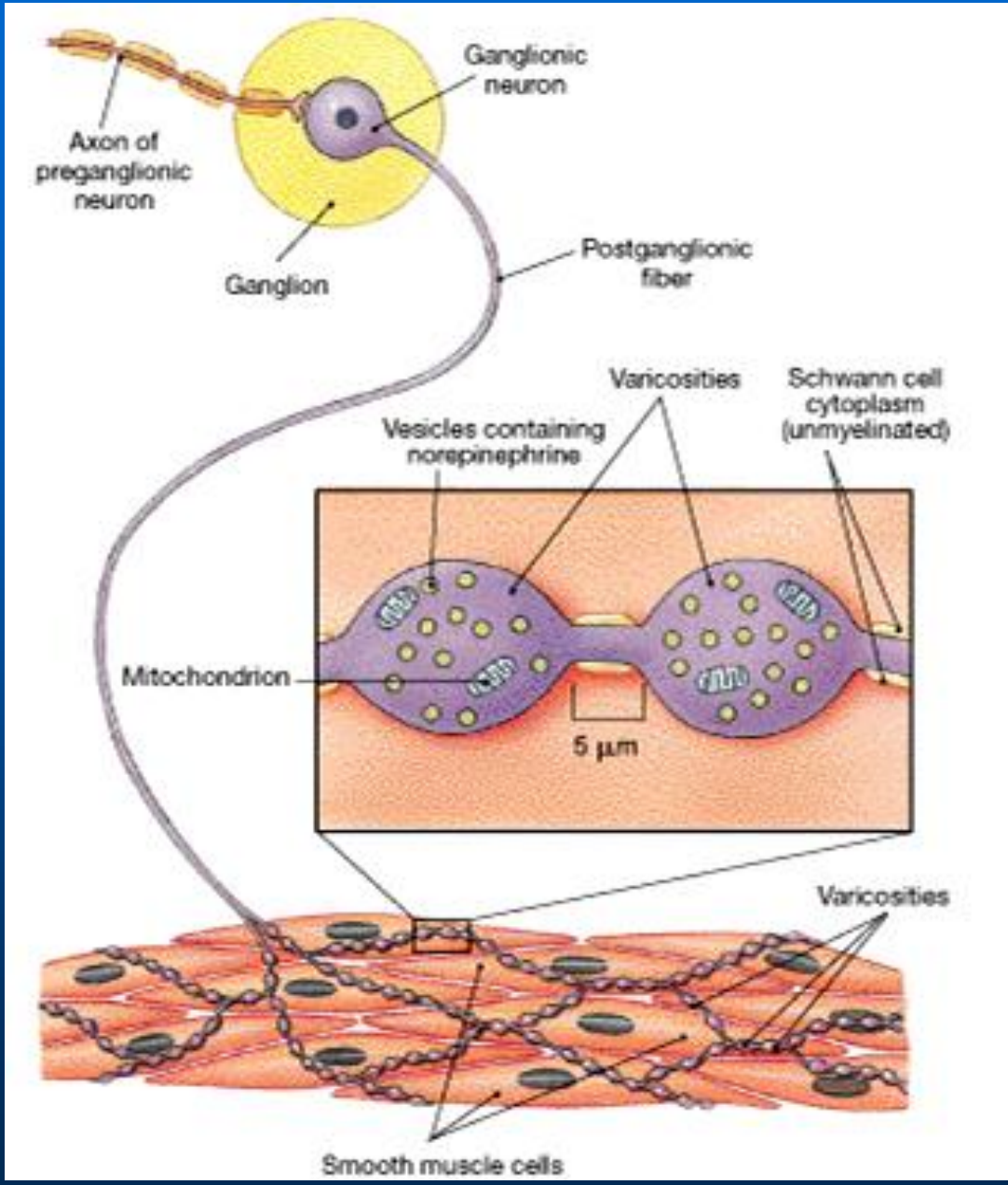
Fig 15.12



2. Sympathetic Neuroeffector Junctions

Differ from somatic neuromuscular junctions

Varicosities contain NT



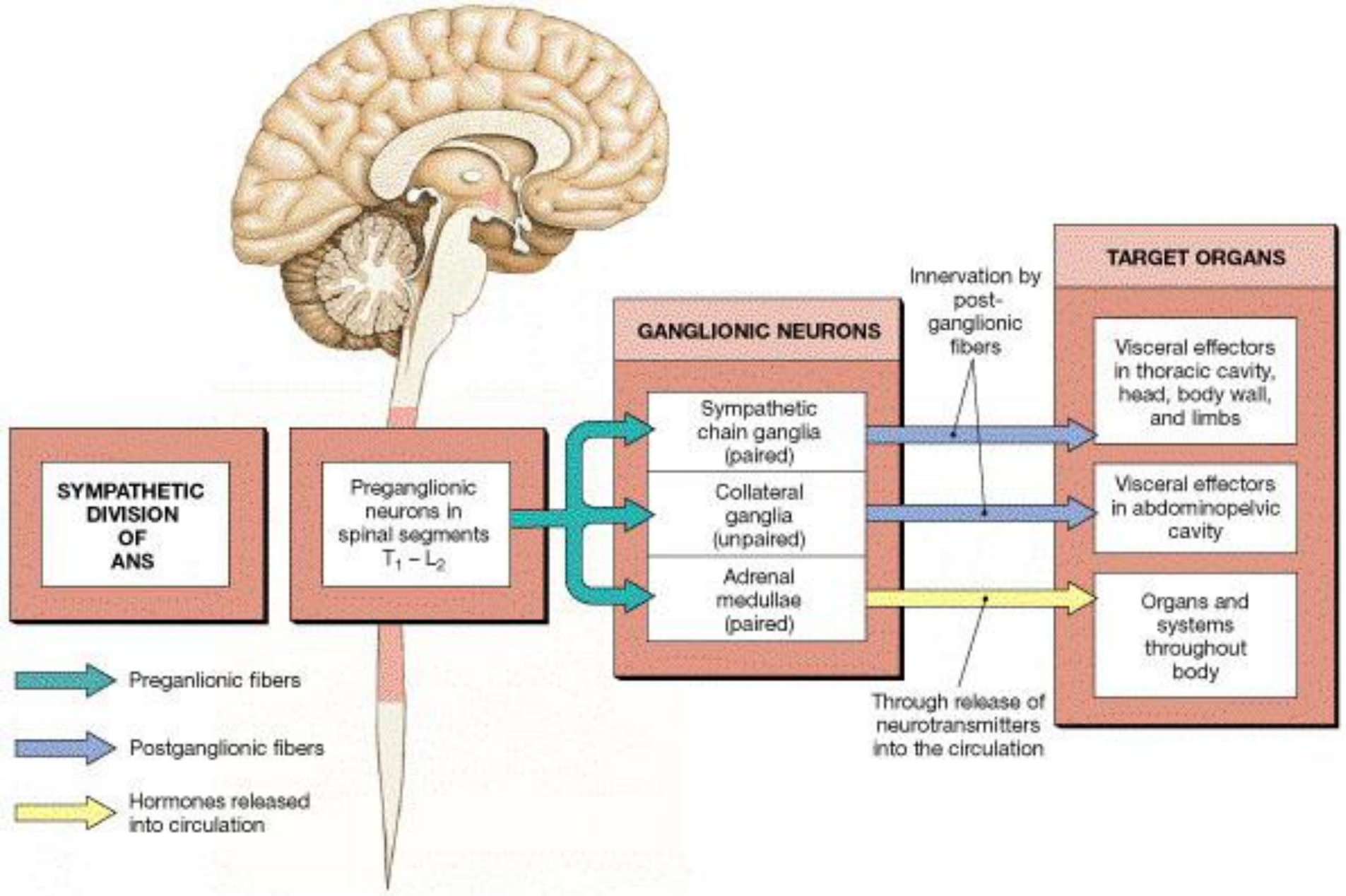

SYMPATHETIC DIVISION OF ANS
Preganglionic neurons in spinal segments $T_1 - L_2$
GANGLIONIC NEURONS
Sympathetic chain ganglia (paired)
Collateral ganglia (unpaired)
Adrenal medullae (paired)
Innervation by post-ganglionic fibers
TARGET ORGANS
Visceral effectors in thoracic cavity, head, body wall, and limbs
Visceral effectors in abdominopelvic cavity
Organs and systems throughout body
Through release of neurotransmitters into the circulation
Preganlionic fibers
Postganglionic fibers
Hormones released into circulation

Fig. 17-6

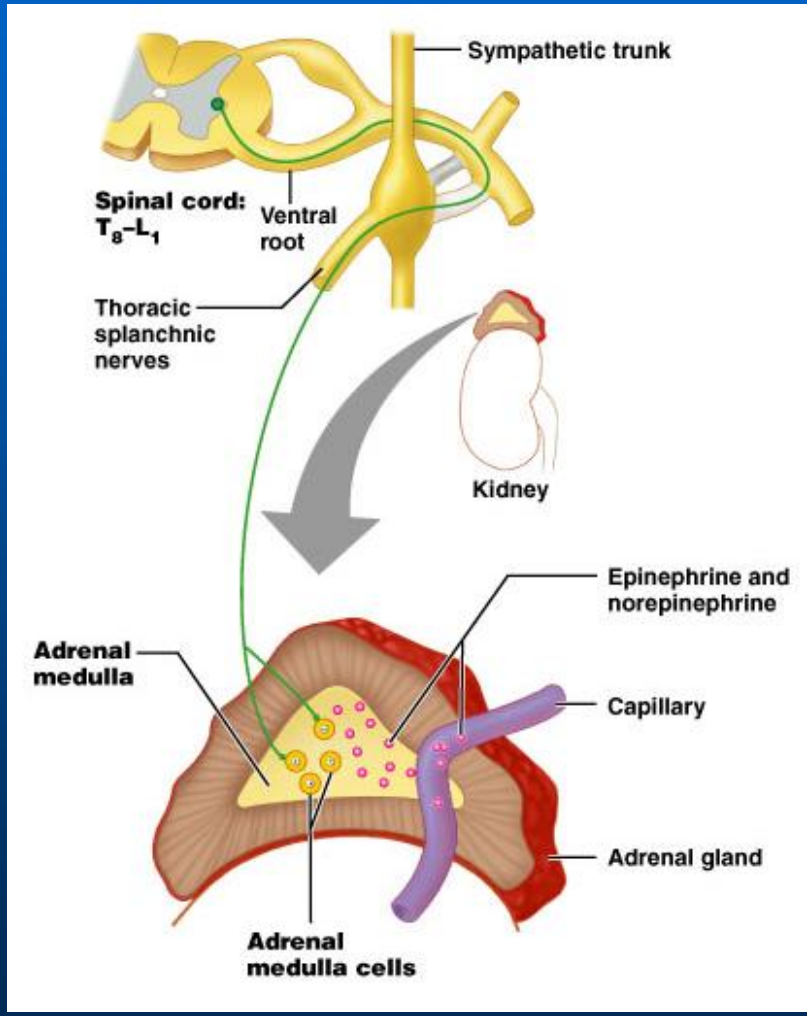
Special Case: Adrenal Medulla

"Modified sympathetic ganglion"

Terminus for neuron #1, stimulates specialized 2nd order neurons with very short axons in adrenal medulla to release NT into blood stream (= hormones)

Epinephrine (adrenaline) ~ 80% and norepinephrine (noradrenaline)

Endocrine effects are longer lasting than nervous system effects



Sympathetic Receptors
(not in book)

Alpha (α-)(Smooth muscle in blood vessels)

Beta (β-)(Heart, resp tract, skeletal muscle)

An enormous number of drugs have their effect at these receptors

2. Summary of Sympathetic Division

A. Neuron #1 is short, neuron #2 is long

B. Synapsing occurs in paravertebral chain ganglia or prevertebral collateral ganglia

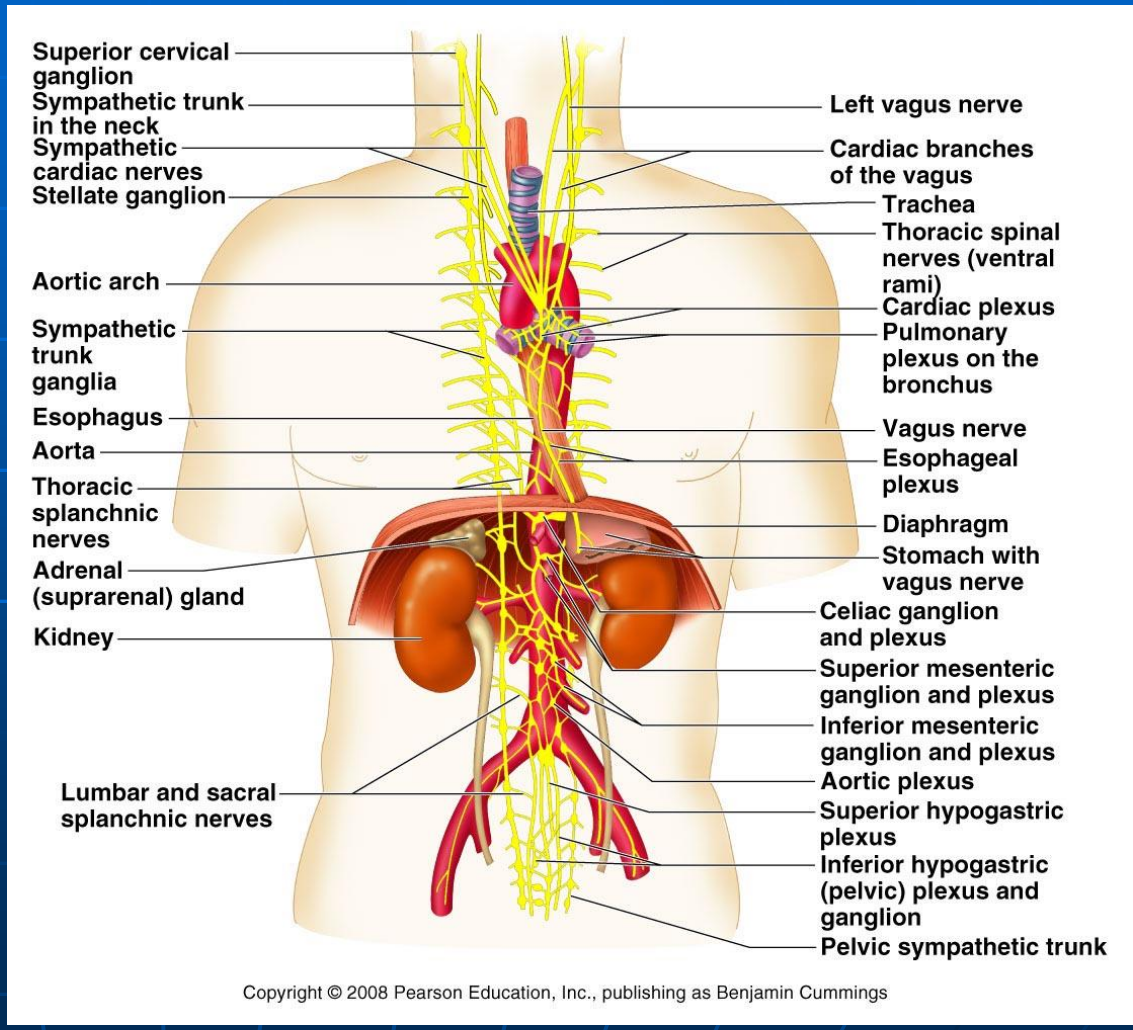
C. Neuron #1 releases Ach, usually neuron #2 releases NE ("adrenergic")

D. Prepares for emergency action, excitatory to many organs, inhibitory to others (digestive for example) "F or F"

E. Effects are very widespread and somewhat persistent; (not as slow as endocrine system)

Dual Innervation

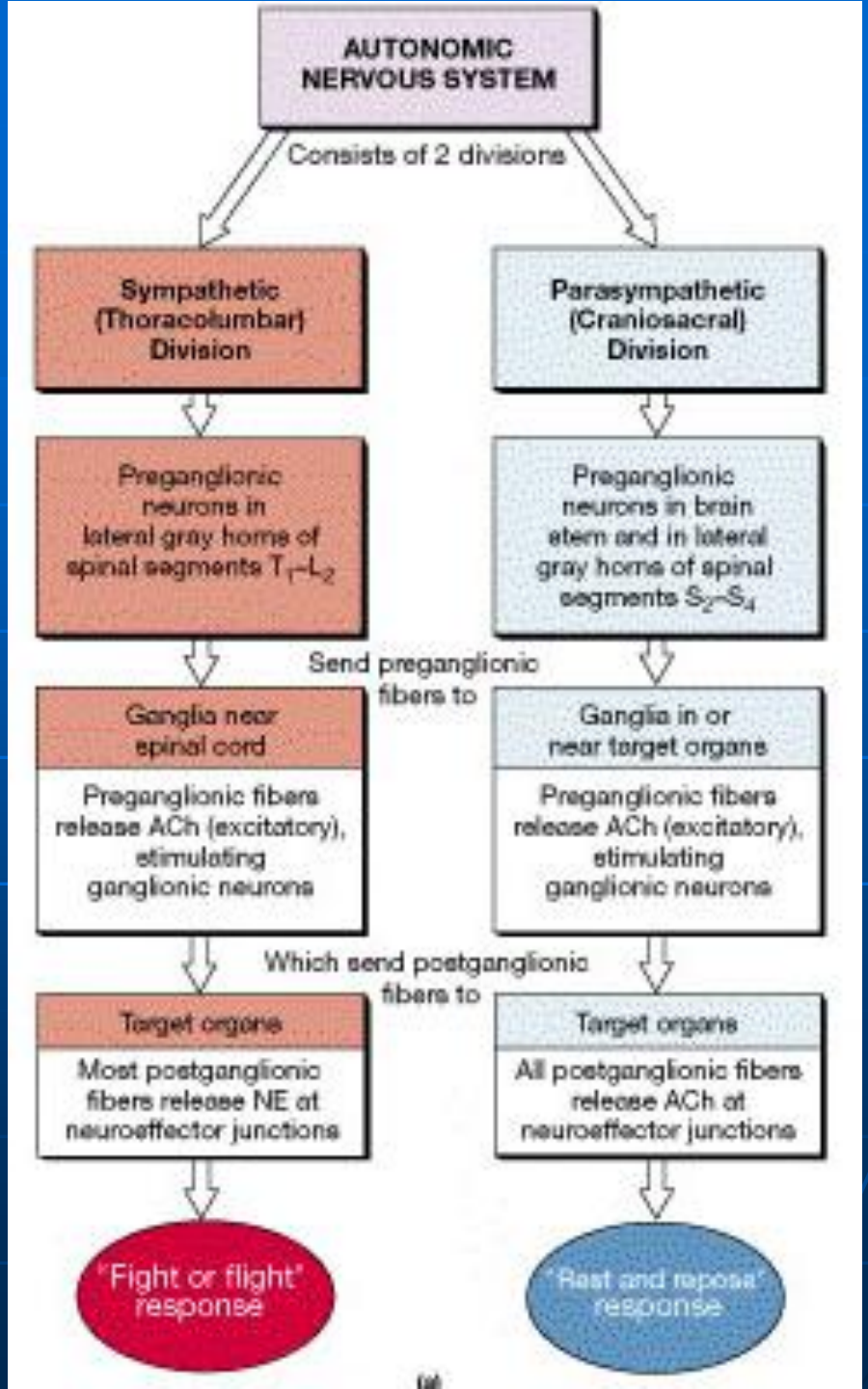
- Each organ receives innervation from sympathetic and parasympathetic fibers
- Fibers of both divisions meet & commingle at plexuses (fig 17-9) to innervate organs close to those centers
- Names of plexuses derived from locations or organs involved



Copyright © 2008 Pearson Education, Inc., publishing as Benjamin Cummings

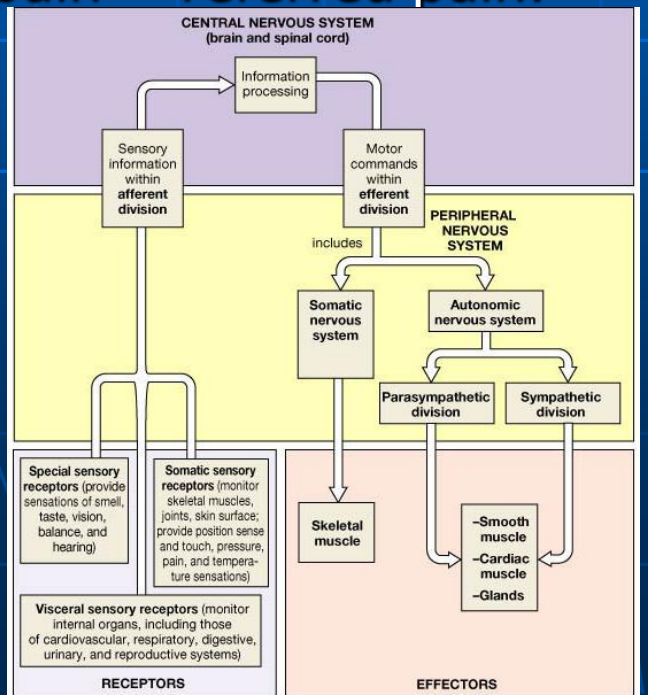
Fig. 15.6

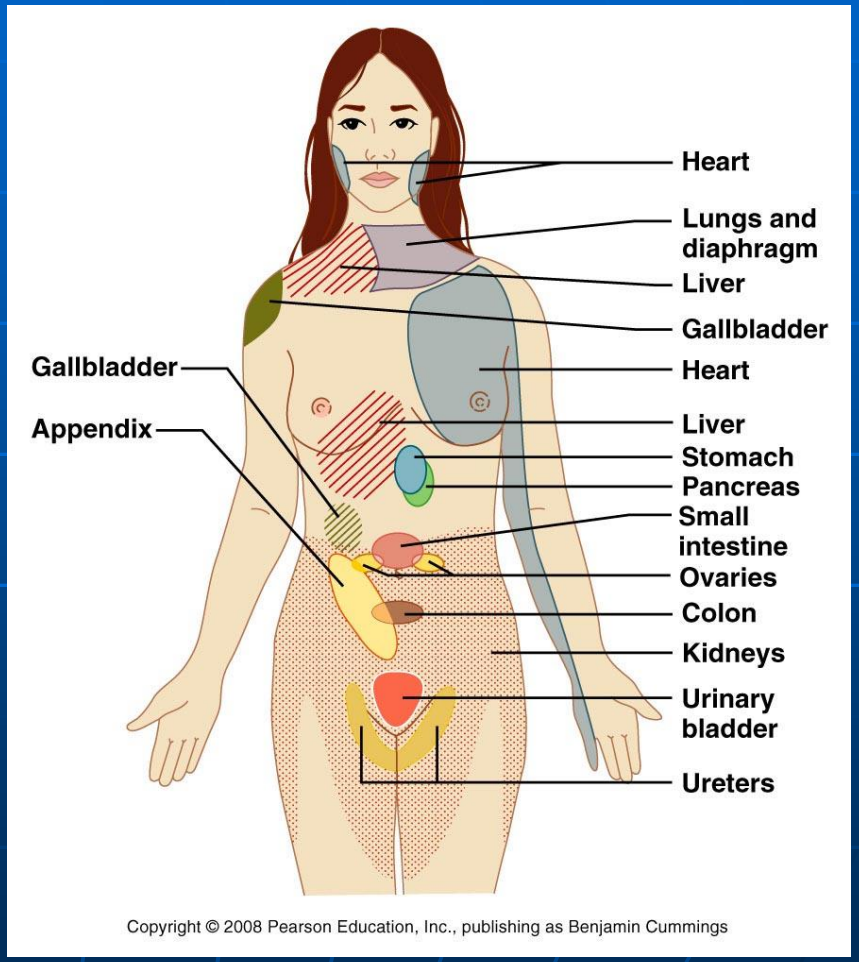
ANS Summary


AUTONOMIC NERVOUS SYSTEM
Consists of 2 divisions
Sympathetic (Thoracolumbar) Division
Parasympathetic (Craniosacral) Division
Preganglionic neurons in lateral gray horns of spinal segments T_1–L_2
Preganglionic neurons in brain stem and in lateral gray horns of spinal segments S_2–S_4
Send preganglionic fibers to
Ganglia near spinal cord
Preganglionic fibers release ACh (excitatory), stimulating ganglionic neurons
Ganglia in or near target organs
Preganglionic fibers release ACh (excitatory), stimulating ganglionic neurons
Which send postganglionic fibers to
Target organs
Most postganglionic fibers release NE at neuroeffector junctions
Target organs
All postganglionic fibers release ACh at neuroeffector junctions
"Fight or flight" response
"Rest and repose" response

Visceral Sensory

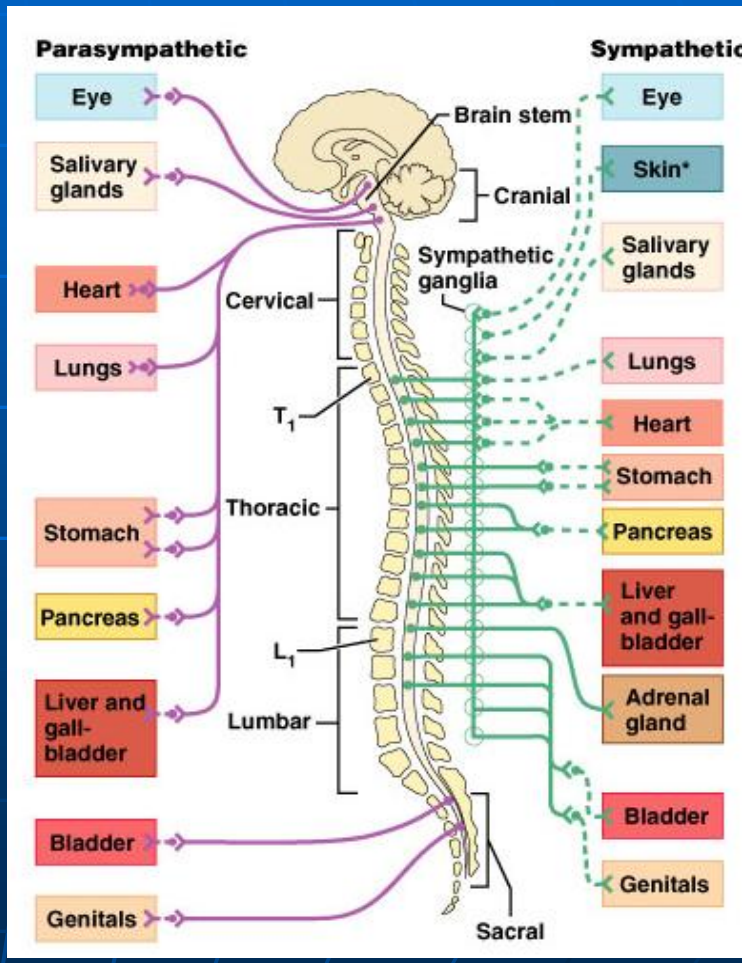
- The interior monitoring
- Much of the input via CN X (Vagus)
- Visceral pain is often perceived as somatic pain—"referred pain."


CENTRAL NERVOUS SYSTEM
(brain and spinal cord)
Information processing
Sensory information within afferent division
Motor commands within efferent division
PERIPHERAL NERVOUS SYSTEM
includes
Somatic nervous system
Autonomic nervous system
Parasympathetic division
Sympathetic division
Special sensory receptors (provide sensations of smell, taste, vision, balance, and hearing)
Somatic sensory receptors (monitor skeletal muscles, joints, skin surface; provide position sense and touch, pressure, pain, and temperature sensations)
Visceral sensory receptors (monitor internal organs, including those of cardiovascular, respiratory, digestive, urinary, and reproductive systems)
RECEPTORS
Skeletal muscle
–Smooth muscle
–Cardiac muscle
–Glands
EFFECTORS



Horner's Syndrome

- Loss of sympathetic innervation to an eye
- Ptosis
- Miosis
- Anhidrosis
- Causes are varied: tumor, aortic aneurism, trauma



Higher Levels of Control

- Common sense tells us that the ANS isn't only automatic. "Higher centers" exert significant control over the ANS
  - Anger => rapid HR
  - Nervousness => sweat